P
Agric
I
Biological
& Medical
Serials

Imperial Agricultural
Research Institute
Delhi

June, 1907 | Chemical Series | Vol. I, No. 3

Memoirs of the Department of Agriculture in India

STORAGE

THE POT-CULTURE HOUSE AT THE AGRICULTURAL RESEARCH INSTITUTE, PUSA

BY

J. WALTER LEATHER, Ph.D., F.I.C., F.C.S

Imperial Agricultural Chemist

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PRINTED BY THACKER, SPINK & CO., CALCUTTA

Price, Rs. 3

JUNE, 1907. CHEMICAL SERIES. VOL. I, NO. 3.

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA.

THE POT-CULTURE HOUSE AT THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

BY

J. WALTER LEATHER, PH.D., F.I.C., F.C.S.,

Imperial Agricultural Chemist.

AGRICULTURAL RESEARCH INSTITUTE, PUSA.

PRINTED BY THACKER, SPINK CO., CALCUTTA.

CALCUTTA:
PRINTED BY THACKER, SPINK AND CO.

THE POT-CULTURE HOUSE AT THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

By

J. WALTER LEATHER PH.D., F.I.C., etc.,

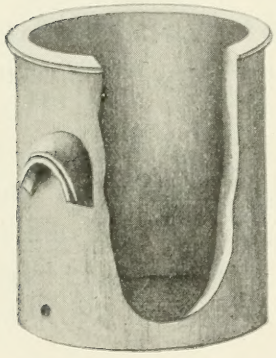
Imperial Agricultural Chemist.

A POT-CULTURE House has been erected at the Agricultural Research Institute, Pusa, in Behar, and it is probable that a description of it, the apparatus employed, and the methods in use, may be of interest to others who utilize this means of investigation.

The Structure.—This includes two parts: the one being a masonry building in which operations may be conducted and plants grown at times when protection from sun and rain is desired, the other an enclosure protected from birds and large insects by wire-netting. The former has an area of 42 × 37 feet, the latter 42 × 47 feet.

The cultivation jars are placed on small trollies in the manner so common to these installations, and these trollies run on rails which extend through both enclosures. By means of a cross-rail, these trollies may be readily conveyed to any part of the building. The nature of the structure is shown in illustration No. 1. No. 2 shows the interior of the wire enclosure. Illustration No. 3 shows that portion of the house which is employed for mixing soils, introducing fertilizers, filling cultivation jars, or the execution of laboratory operations on a table. The floor is masonry. The table is fixed against the wall.

The Cross-rail Trolly.—Two patterns of cross-rail trolly are employed in different Institutes. The one (which is also common to the French railway system) runs on a rail on the same level as the general system, and the trolly is itself above the general level. This pattern is used in the Pot-Culture House at the Woburn Agricultural Station in England. The other pattern runs on rails *below* the general level, and the top of the trolly coincides with this. This pattern is used at Pusa. In the first instance the cross-rail was 13 inches below the ground-level, but as this proved an inconvenience when stepping across it, the axles were recently altered and the cross-rail raised to 6 inches from the ground-level as seen in Plate No. 4. It is indeed simple to construct a trolly which does not require the cross-rail to be more than about 4 inches below the ground-level, and the less this depression, the more convenient for the pedestrian.



No. 5, Cultivation Jar.

Cultivation Jars.—Both glass and stoneware cultivation jars from Europe have been used, but it was found that quite suitable ones could be obtained in India, and at a less cost. The illustration No. 5 shows the pattern which has been adopted. It has no projecting tubulure at the base, but merely a hole. Projecting tubulures are somewhat readily broken, and a simple hole in the jar is sufficient. Very generally, indeed, this is closed by a cork, as in most experiments no drainage occurs. The sizes employed are :—

	Inside depth.	Diameter.	Soil required to fill one jar.
	Inches.	Inches.	Kilos.
A	12	9	15
B	16	9	22
C	22	9	29
D	16	12	31
E	22	12	54

The smallest of these appears to be quite large enough for the perfect development of specimens of most of our field crops.

The Large Beam Scale.—Principally in order to maintain the proportion of moisture in soils as constant as possible, but also for other reasons, the jars of any experiment are weighed every day. For this purpose it is necessary to determine the weight with considerable precision. A differential scale is not sufficiently delicate for this purpose, and a plain beam scale which turns to five grammes with a maximum load of 100 kilos has been adopted. It is seen in illustrations Nos. 6 to 9. Its only peculiar feature is the pair of stirrups, or hooks, in which the jar rests when being weighed. A fruitful source of damage to large plants is the necessity for lifting jars by hand. Even the small ones are so heavy that the operator has to bend over the jar when lifting it, resulting not infrequently in broken plants, and the stirrups were designed in order to obviate this. When used, the trolly is brought to the scale, and the stirrups or hooks are placed on either side of the jar as in the illustrations Nos. 6 or 8; the beam is then depressed by hand until the stirrups will pass under either edge of the jar as in illustration No. 7, or the hooks under the handles (No. 9). The correct weights may then be placed on the pan. Weighing necessarily occupies some time, but as the jars can be dealt with at the rate of 30 per hour, this is not inordinately long, and admits of valuable information regarding loss of water, as well as the regulation of the moisture in the soil. In some cases it would be well to suspend the beam scale from a pulley on an overhead rail. For example, if two rows of jars are on a trolly, the weighing cannot be conveniently executed with a scale hung from a fixed point, but naturally the above arrangement would entail a slight extra expense.

Filling Jars.—The usual practice of experimenters in Europe is to fill the *dry* soil into the cultivation jars, and to add water afterwards at the surface. For many soils this procedure is doubtless sufficient, but for some, such as the fine alluvium of the Indo-Gangetic plain, I have found it inapplicable. When such soils are air-dry, they occupy a larger volume than when

damp, and the consequence is that, if water is added at the surface of a jar of such soil, cracks form which never fill up again, and subsequently added quantities of water are apt to pass straightway to the bottom. In order to obviate this, and indeed as a more perfect method of introducing water uniformly into soils, the filling is effected in the following manner. The weighed quantity of air-dry soil (after adding fertilisers where this is desired) is spread upon the floor. A measured quantity of water is then added from the mouthpiece of a wash bottle, or preferably from a funnel with "rose" attached, in such a way that the water falls on the soil in drops. After adding some of the water, the soil is turned over and any damp lumps broken down by hand. Further portions of the water are then added with alternate working by hand until the whole quantity is uniformly mixed with the soil. The following figures will illustrate the process. 15 kilos of air-dry Pusa soil, spread on the floor, received 1·46 kilos of water about one-fourth at a time. For this soil the quantity of water so introduced is about 10% of the soil. For other soils less or greater amounts of water are introduced, according to their nature. The aim is to introduce a quantity of water which will damp the earth, without, however, making it so damp that the clay could be "puddled" when the jar is filled.

The damped earth is now filled into the jar, and as each handful is introduced, it is levelled and pressed in quite firmly. It is difficult to explain in writing exactly how firmly, but the "doubled" or "clenched" hand is pressed down on it nearly as hard as the operator can do this, without in any way beating the soil. The method results in very uniform packing indeed, the variation being certainly less than 5% by volume between extreme cases, even when more than one operator fills a set of jars. By this method the earth becomes nearly as compact as in the field. In a set of jars recently filled, one cubic foot contained 76 lbs., whilst the subsoil of the locality contained 75 to 87 lbs. per cubic foot.

Addition of fertilisers.—Most substances, which it is desired to add, are introduced while the soil is in the air-dry state. The weighed substance is first mixed intimately with a small handful

of the soil on a board, and a further handful of soil is then mixed in also. This dry powdery material is then scattered uniformly over the main portion of dry soil lying on the floor and the mixture of the whole completed.

Nitrates are sometimes added to the growing plant in irrigation water, but in other cases such substances are added to the soil as described.

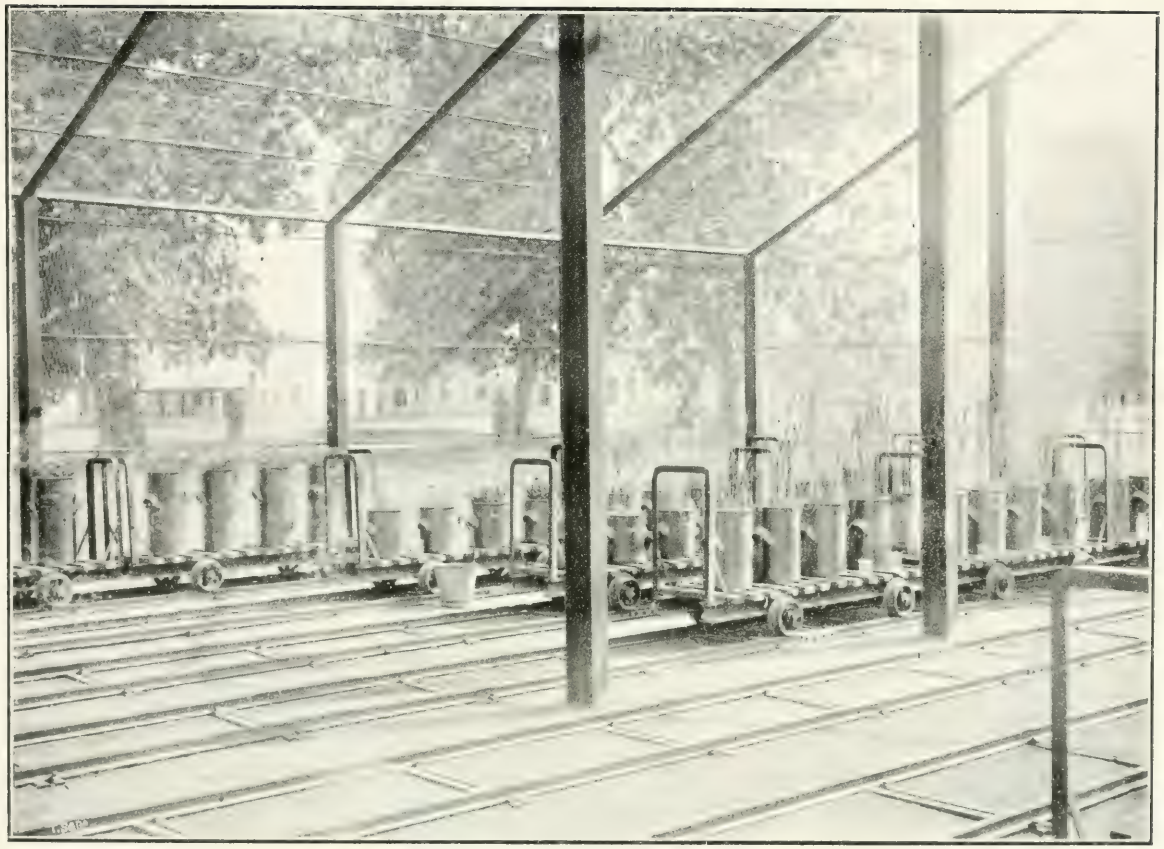
Addition of water.—Experimenters have employed various methods of adding water. By some it is simply poured on to the surface; by others it is introduced to the bottom of the jar by means of a tube, or more rarely through a porous cylinder placed vertically in the upper part of the soil. So far as I am aware, the latter has generally proved a failure. The addition of water at the surface of some Indian soils had, however, been so productive of cracking and caking, that experiments were made during the cold weather of 1905-6 to determine whether the water could not be introduced below the surface, so as to preserve this in an "open" condition. Both deep and shallow jars were employed, and three formed a unit. To one the water was added at the surface, to the second it was introduced by a tube to the bottom of the jar and into the third it was introduced by means of a porous cylinder. This latter method is very commonly employed to irrigate trees in India, in which case a porous spherical vessel is sunk in the ground near the base of the tree and kept full of water. The same weight of water was always added to the three jars of any one set. No manure was employed. The plants (oats) were reduced to 10 in each jar after germination, and afterwards to five, and from the weight of the thinnings an estimate was made of the rate of growth; finally, the weight of the harvested plants was obtained. The result is shown diagrammatically (chart No. 10), and it is clear that, at least for this soil, there can be no doubt about the great advantage of introducing water below the surface. The jars to which water was added at the base produced the most, those to which it was introduced through the porous cylinders came next, and, thirdly, those irrigated at the surface. A difficulty was indeed experienced in adding

water quickly by either of the former methods, because it percolated very slowly not only through the porous cylinders but also into the soil at the base of the jars. Moreover, the latter method necessitated the use of a funnel and tube which were inconvenient.

For the present, porous cylinders are employed, and in order to admit of the more expeditious percolation of the water, they are pierced with small holes in the side, and are also made as large as is compatible with the size of the jars. The quantity of water transpired by plants when growing vigorously is considerable—a dozen young wheat plants may transpire upwards of one kilogramme per day, and usually the whole of this cannot be re-introduced into the soil in less than a couple of hours. The result is, however, entirely satisfactory so far as the surface soil is concerned, since it retains its loose pulverulent character and cracks and caking are avoided even when the proportion of water is maintained at 20%.

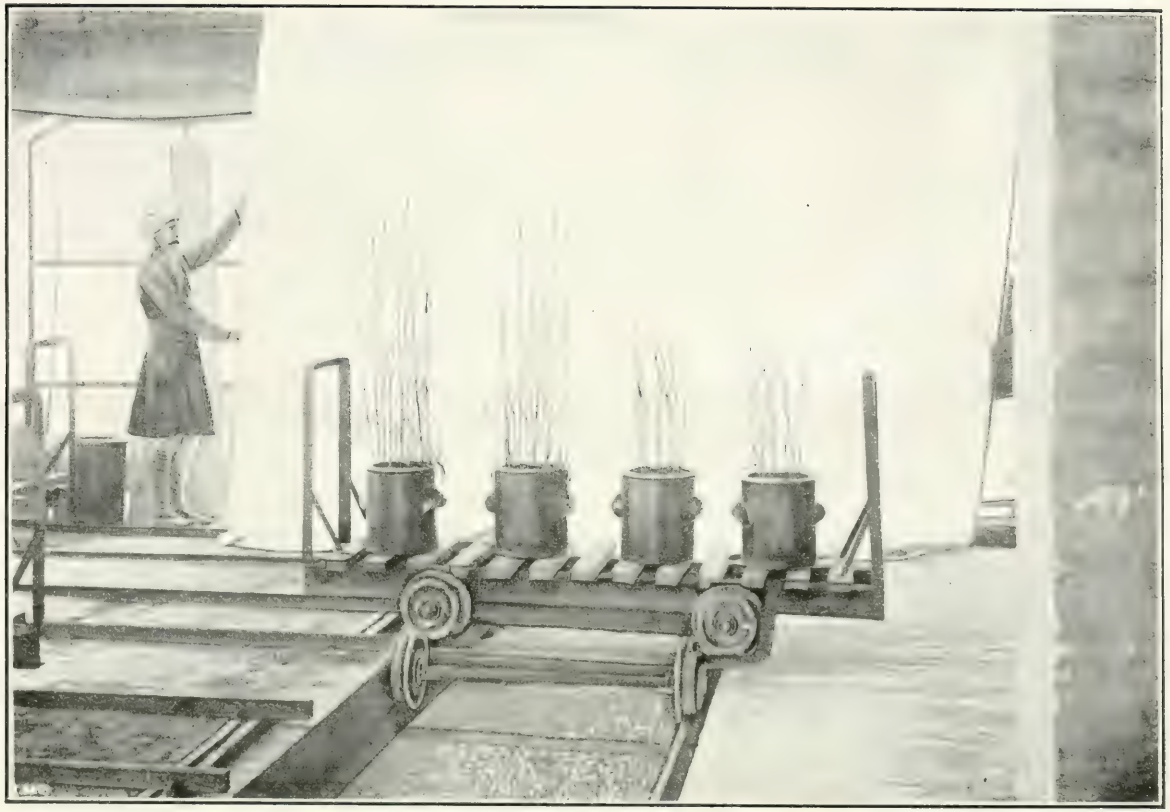
Thinning.—More seeds are usually sown in the first instance than the number of mature plants ultimately required. This is in part necessary since faulty germination is so frequent. But in addition to this, surplus plants provide a means of forming an estimate of the weight of the plants during the initial period of an experiment. After the young plants have fairly established themselves, the number may be reduced, and those which are cut out, weighed; from which the above data are calculated. Discretion is naturally used as to which plants are cut out, and these may be smaller than those remaining, so that the estimate involves some inaccuracy, but with good seeds, producing uniform germination, this source of inaccuracy is very small. Thinning is more particularly useful, for annuals, during the earlier stages of growth, before the plants have tillered much; if done later, the remaining plants will not develop more than if the number had not been reduced.

No. 1. The Pot Culture House.

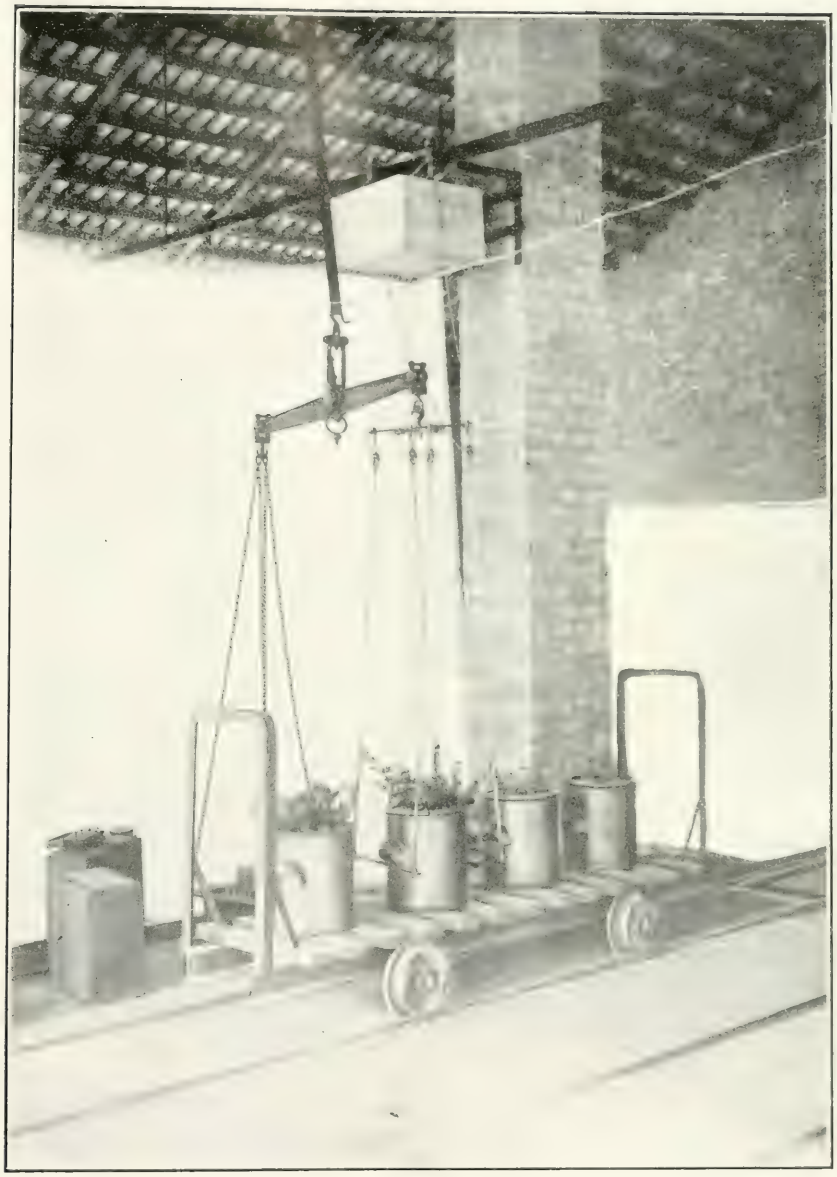


No. 2. Interior of Wire enclosure.

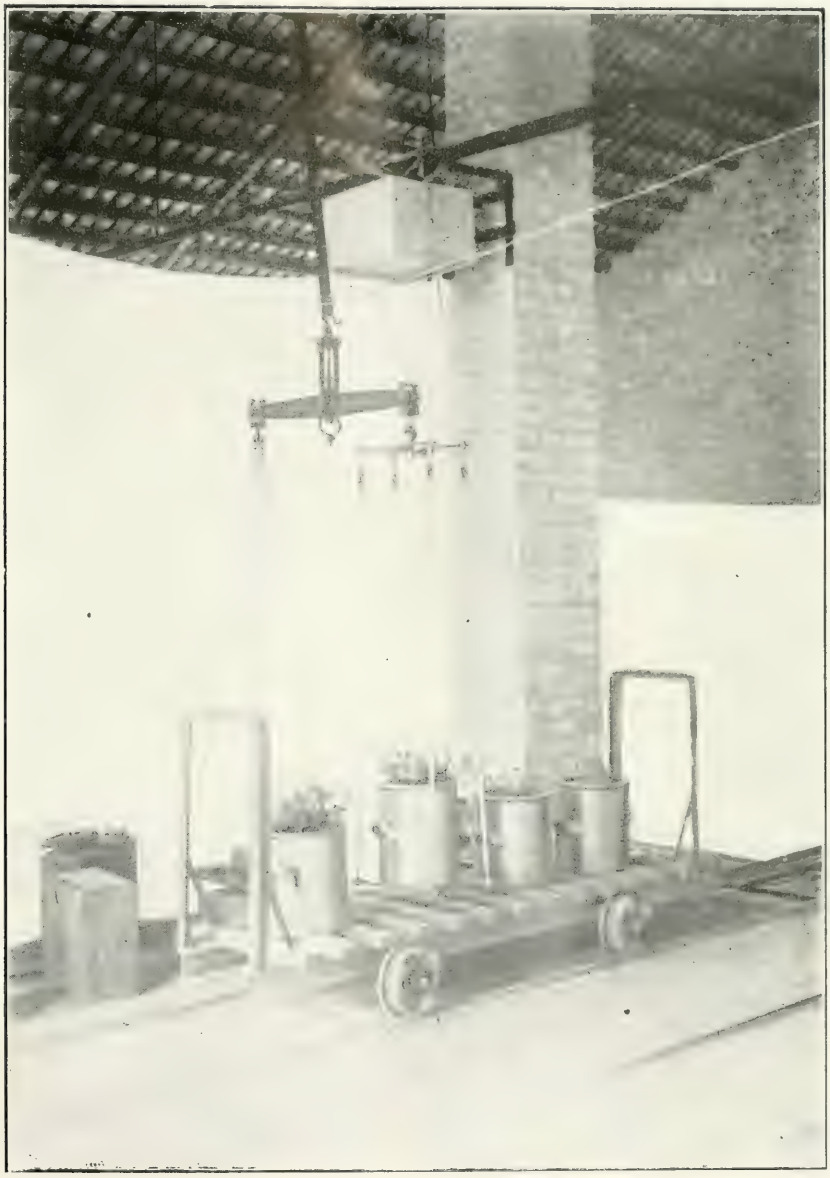
No. 3. Interior (Laboratory end).



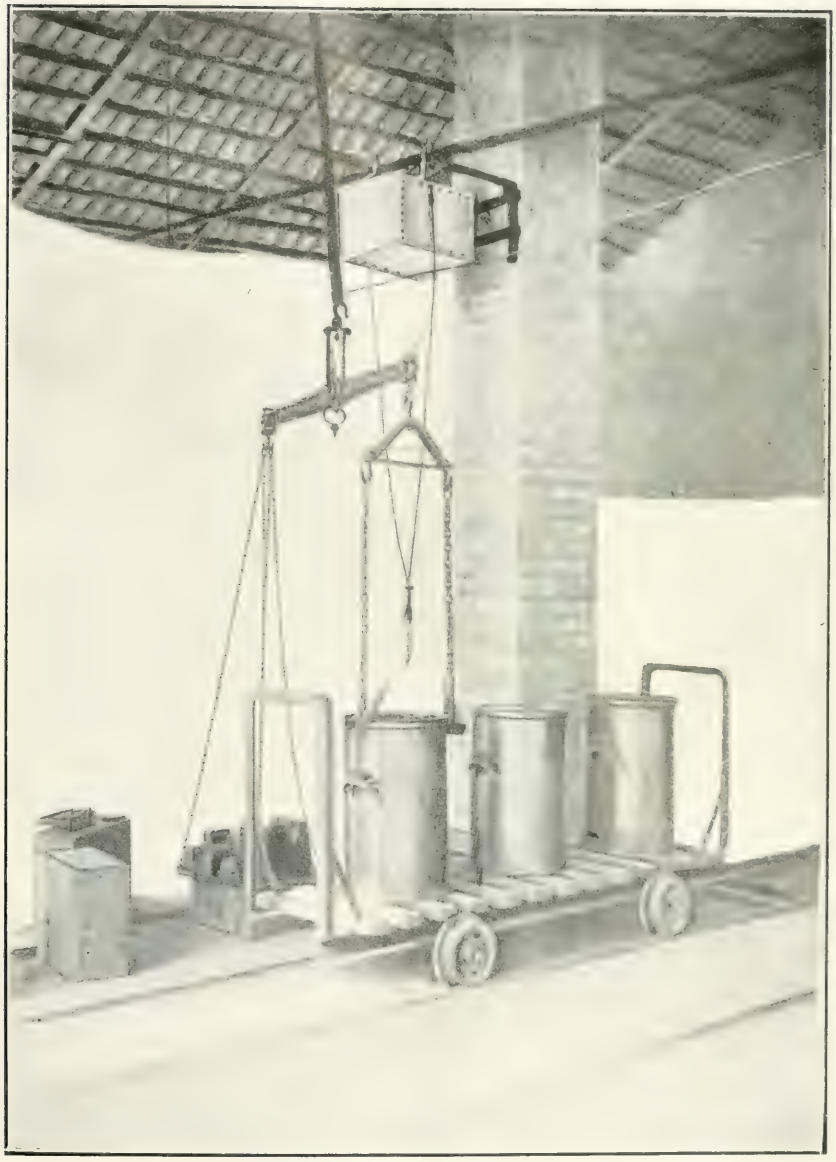
No. 4. The cross-rail trolly.



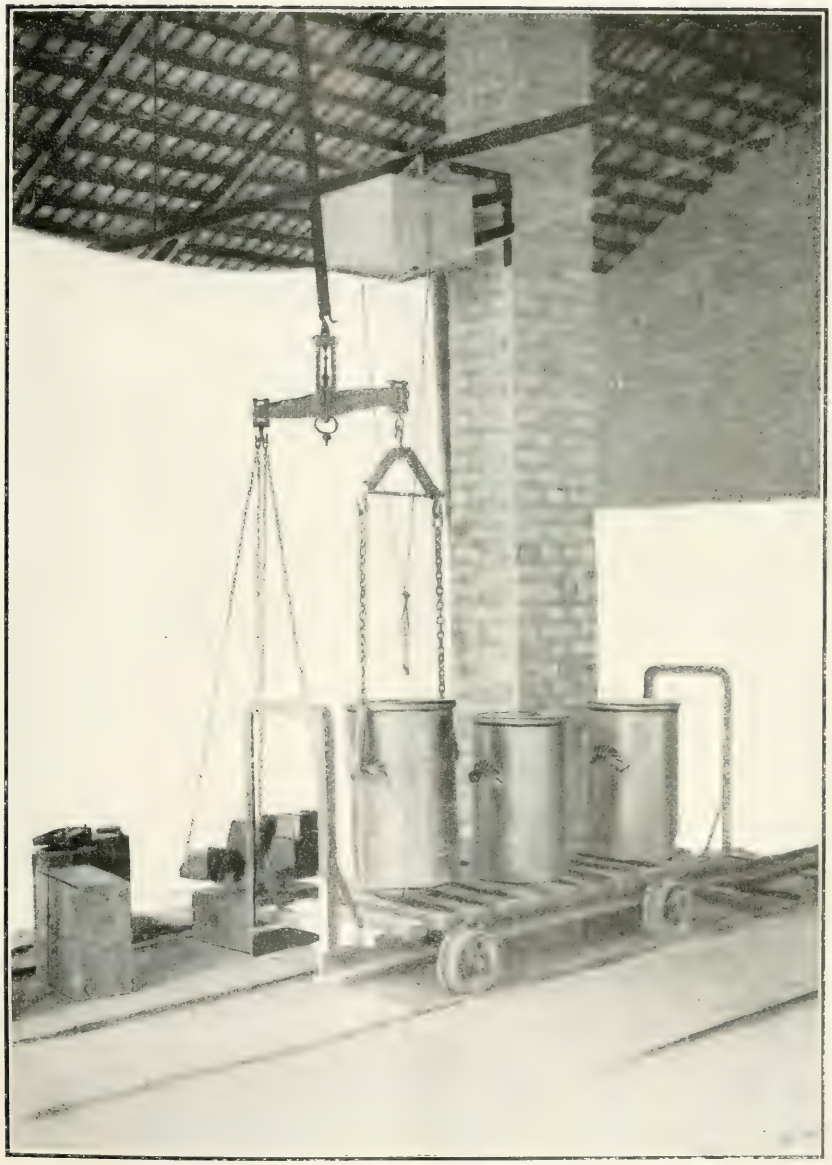
No. 6. The beam scale, showing the stirrups before being placed under the jar.



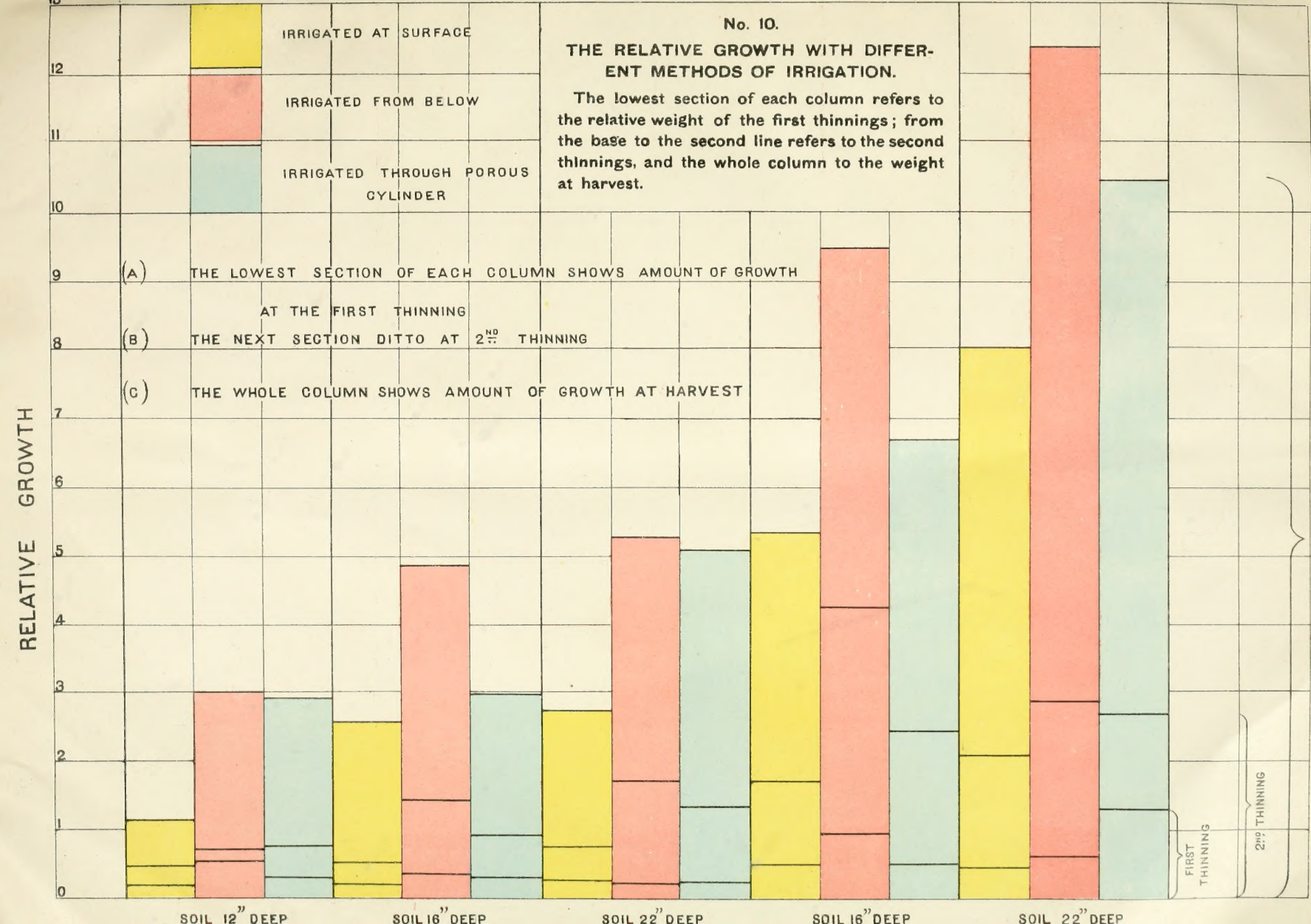
No. 7. The beam scale, showing the jar resting in the stirrups.



No. 8. The beam scale, showing the hooks before attachment to the jar.



No. 9. The beam scale, showing the jar resting in the hooks.


No. 10.
THE RELATIVE GROWTH WITH DIFFERENT METHODS OF IRRIGATION.
The lowest section of each column refers to the relative weight of the first thinnings; from the base to the second line refers to the second thinnings, and the whole column to the weight at harvest.
IRRIGATED AT SURFACE
IRRIGATED FROM BELOW
IRRIGATED THROUGH POROUS CYLINDER
(A) THE LOWEST SECTION OF EACH COLUMN SHOWS AMOUNT OF GROWTH AT THE FIRST THINNING
(B) THE NEXT SECTION DITTO AT 2ND THINNING
(C) THE WHOLE COLUMN SHOWS AMOUNT OF GROWTH AT HARVEST
RELATIVE GROWTH
0
1
2
3
4
5
6
7
8
9
10
11
12
FIRST THINNING
2ND THINNING
SOIL 12" DEEP
SOIL 16" DEEP
SOIL 22" DEEP
SOIL 16" DEEP
SOIL 22" DEEP

NOTICE.

THESE Memoirs, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

BOTANICAL SERIES.

Vol. I, No. I. The Haustorium of the Santalum Album—Early Stages by C. A. BARBER, M.A., F.L.S. Price, Re. 1.

Part II.—Cases of Irregular Penetration by C. A. BARBER, M.A., F.L.S. *(In the press.)*

Vol. I, No. II. Indian Wheat Rusts by E. J. BUTLER, M.B., F.L.S., and J. M. Hayman. Price, Rs. 3.

Vol. I, No. III. Fungus Diseases of Sugar-cane in Bengal by E. J. BUTLER, M.B., F.L.S. Price, Rs. 3.

Vol. I, No. IV. Gossypium obtusifolium, Roxburgh, by I. H. BURKILL, M.A. Price, Re. 1.

Vol I, No. V. An Account of the Genus Pythium and some Chytridiaceæ by E. J. BUTLER, M.B., F.L.S. Price, Rs. 4-8.

Vol. I, No. VI. Cephaleuros virescens, Kunze; The Red Rust of Tea by HAROLD H. MANN, D.SC., and C. M. HUTCHINSON, B.A. Price, Rs. 4. *(In the press.)*

Vol. II, No. I. Some Diseases of Cereals caused by Sclerospora Graminicola by E. J. BUTLER, M.B., F.L.S. Price, Re. 1-8.

CHEMICAL SERIES.

Vol. I, No. I. The Composition of Indian Rain and Dew by J. W. LEATHER, PH.D., F.C.S. Price, Re. 1.

Vol. I, No. II. The Composition of Oil Seeds by J. W. LEATHER, PH.D., F.C.S. Price, Re. 1.

Vol. I, No. III. Part I.—The Pot-Culture House at the Agricultural Research Institute, Pusa, by J. W. LEATHER, PH.D., F.C.S. Price, Rs. 3.

Vol. I, No. IV. Part I.—Experiments on the Availability of Phosphates and Potash in Soils by J. W. LEATHER, PH.D., F.C.S. *(In the press.)*

Vol. I, No. V. Part I.—Construction of Drain Gauges at Pusa by M. H. ARNOTT, M. INST. C.E.; and J. W. LEATHER, PH.D., F.C.S. *(In the press.)*

ENTOMOLOGICAL SERIES.

Vol. I, No. I. The Bombay Locust by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2-8.

Vol. I, No. II. The more Important Insects injurious to Indian Agriculture by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 3.

Vol. I, No. III. The Indian Surface Caterpillars of the Genus Agrotis by H. M. LEFROY, M.A., F.E.S., F.Z.S., and C. C. GHOSH, B.A. Price, Re. 1-8.

Vol. I, No. IV. Individual and Seasonal Variations in Helopeltis Theivora, Waterhouse, with description of a new species of Helopeltis by HAROLD H. MANN, D.SC. Price, Re. 1-8.

Vol. I, No. V. The Coccidæ attacking the Tea Plant in India and Ceylon by E. E. Green, F.E.S., and HAROLD H. MANN, D.SC. *(In the press.)*